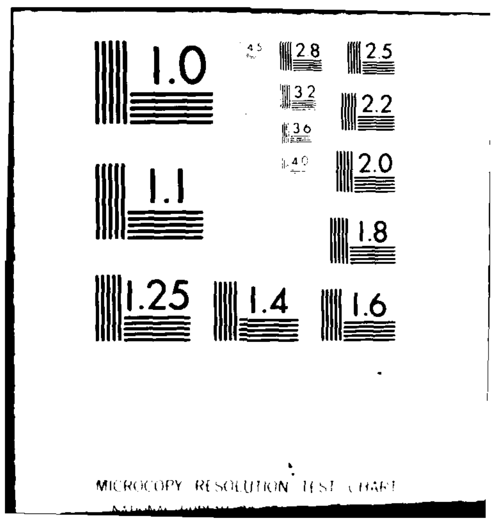
AD-A097 120 CIVIL ENGINEERING LAB (NAVY) PORT HUENEME CA F/G 5/9
FACILITY HYGIENE PRACTICES ASSOCIATED WITH ASBESTOS THERMAL INS--ETC(U)
OCT 80 E E LORY
UNCLASSIFIED CEL-TN-1591 NL

1 OF 1
AD A
097120

END
DATE
FILMED
5-81
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
MICROCOPY RESOLUTION TEST CHART

LEVEL II

(12)

AD A097120

Technical Note

CEL

TN no. N-1591

title: FACILITY HYGIENE PRACTICES ASSOCIATED WITH ASBESTOS THERMAL INSULATION

author: E. E. Lory

date: October 1980

sponsor: Naval Facilities Engineering Command

program nos: YF65.572.091.01.008

DEPARTMENT OF THE NAVY
CIVIL ENGINEERING LABORATORY

CIVIL ENGINEERING LABORATORY
NAVAL CONSTRUCTION BATTALION CENTER
Port Hueneme, California 93043

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: TN-1591	2. GOVT ACCESSION NO.: DN787032	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): FACILITY HYGIENE PRACTICES ASSOCIATED WITH ASBESTOS THERMAL INSULATION		5. TYPE OF REPORT & PERIOD COVERED: Final; May – Jun 1980
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): E. E. Lory		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: CIVIL ENGINEERING LABORATORY, Naval Construction Battalion Center, Port Hueneme, California 93043		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62765N; YF65.572.091.01.008
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Facilities Engineering Command, Alexandria, Virginia 22332		12. REPORT DATE: October 1980
		13. NUMBER OF PAGES: 13
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS (of this report): Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Asbestos, fibers, dust control, Naval shore facilities, exposure (industrial), safety procedures, maintenance, personnel health, hygiene.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Guidance on appropriate practices for cleaning workplaces that have significant amounts of asbestos-containing thermal insulation is presented. Recommended procedures for floors, walls, machinery and equipment, and overhead areas are provided. Recommended cleaning methods are given for HEPA-filtered vacuum cleaners, wet-cleaning with amended water, and chemical-impregnated equipment. As a general guide, overhead structures and walls should be vacuumed annually, and floors and equipment vacuumed on a regular cleaning schedule.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Civil Engineering Laboratory
FACILITY HYGIENE PRACTICES ASSOCIATED WITH ASBESTOS THERMAL INSULATION (Final), by E. E. Lory
TN-1591 13 pp illus October 1980 Unclassified

1. Asbestos, fiber release 2. Health, asbestos-related I. YF65.572.091.01.008

Guidance on appropriate practices for cleaning workplaces that have significant amounts of asbestos-containing thermal insulation is presented. Recommended procedures for floors, walls, machinery and equipment, and overhead areas are provided. Recommended cleaning methods are given for HEPA-filtered vacuum cleaners, wet-cleaning with amended water, and chemical-impregnated equipment. As a general guide, overhead structures and walls should be vacuumed annually, and floors and equipment vacuumed on a regular cleaning schedule.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

CONTENTS

	Page
INTRODUCTION	1
BACKGROUND	1
ENVIRONMENTAL MONITORING	2
MAINTENANCE OF THERMAL INSULATION	2
SAFETY PROCEDURES FOR PERSONNEL PROTECTION	3
RECOMMENDED HYGIENE PROCEDURES	3
Floors	3
Walls	4
Machinery and Equipment	4
Overhead	4
RECOMMENDED CLEANING METHODS	4
Vacuum	5
Amended Water	6
Chemical-Impregnated Equipment	7
RECOMMENDATIONS	7
REFERENCES	7

FOREWORD

Occupational Safety and Health Administration (OSHA) Standards imposed on the Navy by Executive Order 11612 and 11807, followed by OPNAVINST 5100.8C and 6240.30, require implementation of health and safety methods for Naval personnel. OSHA Standard 1910.1001 and OPNAVINST 6260.1A are concerned with the control of asbestos emissions for the protection of personnel and the environment.

OSHA regulations must be adhered to by all Federal agencies. Work performed by Public Works Departments or by private contractors aboard Naval installations must comply with these regulations.

INTRODUCTION

The Civil Engineering Laboratory (CEL) has been tasked by the Naval Facilities Engineering Command (NAVFAC) to develop guidance on appropriate practices for cleaning workplaces that have significant amounts of asbestos-containing thermal insulation. Many types of asbestos insulation products have been used in Navy construction in a variety of steam and hot water systems. The diversity and various states of maintenance have led to concern in determining appropriate practices for facility hygiene. Also, when the new Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) regulations came into force, the protection of workers from industrial disease became a statutory obligation wherever asbestos materials are used in such a way as to give rise to the emission of dust dangerous to the health of employees. These regulations have placed new burdens on facility and safety managers to insure proper practices for removing accumulated hazardous asbestos dust and achieving satisfactory working conditions.

This technical note is one of a series of documents prepared by CEL on asbestos construction products at Naval Shore Facilities. The primary guidance document is the Management Procedure for Assessment of Friable Asbestos Insulating Products (Ref 1). The information assembled in this investigation was developed through a search of pertinent literature and through contacts with EPA. This type of information is essential to facility and safety managers to insure regulation compliance and cost-effective operations. Also, it provides a basis for decisions regarding the direction of further development in this area. Supplementary technical notes to this guidance document will be prepared on subjects related to asbestos-containing products, such as encapsulation methods, thermal pipe insulation maintenance procedures, applied insulation demolition techniques, and handling and disposal of asbestos-containing waste.

BACKGROUND

Asbestos is a general term used to describe several fibrous hydrated silicate minerals known for their high tensile strength, high flexibility, durability, and heat and chemical resistance. Only six of these asbestiform silicates -- chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite -- are of major commercial importance. In the past decade, there has been an increasing awareness of the significance of environmental contamination as a cause of disease. The physical characteristics of asbestos fibers and the widespread and varied uses of asbestos-containing products have caused concern for human exposure within buildings that contain such material. The hazard potential from such exposure for the population involved may be relatively high. Because of widespread use and ease of fiber dissemination, asbestos-containing thermal insulation can be considered one of the most significant sources of asbestos fibers in the indoor environment.

The potential for fibers to enter the workspace environment depends upon type of construction material, structural form, and building use. Fiber dissemination is a function of the frequency and amount of energy delivered to the asbestos-containing material, normally through the generation of air currents and mechanical agitation.

Relevant characteristics of asbestos fibers include durability and high aerodynamic capability, both of which directly influence the probability for long-term contact. Once in the workspace, the fibers exhibit low settling velocities, remaining in the inhalation contact zone for long periods of time. As calculated from settling curves generated specifically for asbestos fibers, a 1.0 μm fiber with a 5:1 aspect ratio, falling from 3 meters with variable axis attitude, will exhibit a settling velocity of 10^{-3} cm/sec and remain airborne for over 80 hours. Furthermore, settled fibers have aerodynamic capability and may experience reentrainment cycles if disturbed. Such fibers contained within workspaces can repeatedly present an exposure situation and an opportunity for inhalation or ingestion.

ENVIRONMENTAL MONITORING

Airborne asbestos dust is usually monitored for one of three reasons. First, large numbers of samples are taken to check compliance with legislation with regard to persons involved directly in asbestos control measures. Second, determinations are made regarding the efficacy of engineering dust suppression measures. Last, the asbestos is monitored for epidemiologic purposes. Therefore, air monitoring is used to estimate concentration levels of airborne fiber before, during, and after facility hygiene operations. The federal government requires monitoring of employee exposure to determine whether each employee's exposure to asbestos fibers is below the current limits.

Sampling and analysis for airborne asbestos may establish the existence of asbestos contamination (see Reference 1 for details). An adequate study of airborne contamination requires sampling during various indoor activities and sampling of outside or community ambient levels, with inclusion of control samples. Sampling within a structure under only quiet conditions may be particularly misleading because asbestos fibers usually become airborne as a result of disturbance through human activity. Direct monitoring of persons engaged in these activities will best define potential exposures.

MAINTENANCE OF THERMAL INSULATION

In facilities with asbestos-containing thermal insulation, all machinery, equipment, and internal surfaces of the building should be kept, so far as is practicable, in a clean state and free from asbestos waste and dust. Scheduled preventive maintenance and inspection of thermal insulating systems should be conducted at least once a year, but preferably at 6-month intervals. Reliability of the piping system and trouble-free service life can be increased by such scheduling. Preventive maintenance also insures maximum thermal conservation.

Another aspect of the preventive maintenance inspection is locating pipe insulation damage, which is a potential source of asbestos fiber release and subsequent exposure of workers. Fiber release is dependent on the extent of damage, the incidence of repeated disturbance, and available air currents or turbulence to carry the hazardous fibers into the respirable (breathing) zone. It should be noted that when thermal pipe insulation, including asbestos-containing insulation, is properly maintained and lagged, there is no danger of fiber release.

All damaged thermal insulation should be repaired before the facility's hygiene operation begins (see Reference 1 for details). Proper maintenance will protect the insulation from further damage and will also prevent fiber disturbance during the cleaning operation.

SAFETY PROCEDURES FOR PERSONNEL PROTECTION

Safety and health requirements for conforming with OSHA, EPA, and Navy regulations must be complied with according to exposure levels when work is to be accomplished by Navy personnel, civilian personnel, or outside contractors. To insure personnel are not being exposed to asbestos fiber levels, protective equipment must be worn.

Any respirator used must be approved for protection against exposure to asbestos by the Mine Safety and Health Administration (MSHA, formerly MESA) or the National Institute for Occupational Safety and Health (NIOSH). For facility hygiene operations (i.e., nonrip-out asbestos operations), the type of respirator is determined by the asbestos fiber concentration in the breathing zone during worst case conditions. Generally, reusable or disposable single-use air purifying respirators will provide the required protection.

Disposable headcovers and shoe covers, coveralls (or a disposable sock suit constructed of TWEK or other similar material documented to be of equivalent resistance to penetration of asbestos), gloves, and goggles are generally recommended.

For additional guidance, the cognizant safety specialist or industrial hygienist should be consulted.

RECOMMENDED HYGIENE PROCEDURES

Procedures for facility hygiene operations have been described by the Asbestos Research Council (Ref 2). Their recommendations include the following.

Floors

Contamination of working areas from accumulation of waste material on floors must be avoided by regularly cleaning with a dustless method. The first choice of a dustless method for cleaning would be by vacuum, either from a fixed source or a mobile unit. Alternative methods would include thorough damp mopping of the floor or the use of chemical-impregnated mops.

Walls

Annual cleaning of the walls should be sufficient. Walls may be cleaned either by vacuuming or by washing down using amended water.

Machinery and Equipment

The method to be used for cleaning equipment depends on the degree of contamination, the type of material, and whether the material is contaminated with oil or water. It is preferable to use vacuum cleaners, either of the fixed or mobile type, with suitable extension leads. Inaccessible parts of the equipment may be cleaned out with chemical-impregnated brushes or cloths and then vacuum equipment used to collect the material so removed.

Overhead

The most difficult cleaning operation that has to be undertaken on a regular basis in any facility with significant asbestos materials is overhead cleaning in high buildings. The frequency of cleaning overhead structures will vary significantly from one facility to another. As a general guide, overhead structures should be cleaned once a year or when asbestos dust has accumulated.

Ideally, either permanent or mobile lightweight staging would be used by the cleaners to reach the areas that are inaccessible from ground level. Where there are no obstructions at ground level, telescoping equipment would be suitable.

If an area could possibly contain dust, it should be removed by vacuuming, using extension hoses where necessary. Some places may, however, be inaccessible or the accumulation of dust be tenacious; in these cases, it will be necessary to resort to hand brushing with chemical-impregnated equipment.

Where dustless methods of cleaning are not practicable, protective clothing and approved respirators must be worn by all personnel present in the building. It is recommended that such protective clothing and respirators be worn by all personnel engaged in overhead cleaning regardless of the method used.

Equipment located beneath an overhead cleaning area should be covered with plastic sheets, so far as is practicable, in order to simplify the subsequent general cleaning of the area.

Since overhead cleaning may only be possible when work is stopped, cleaning may have to be scheduled for weekends. Night cleaning is not recommended because the area being cleaned is above the level of the light fixtures and, therefore, the lighting is usually inadequate. Cleaning may be undertaken by contract cleaners. However, the nature of the hazard must be made clear to the contractor, and the contractor must comply with all regulations.

RECOMMENDED CLEANING METHODS

All necessary cleaning must be by vacuum or by wet or chemical cleaning, since dry sweeping and similar procedures create more, rather than fewer, dust problems. Under NO circumstances should compressed air cleaning be used.

Vacuum

Vacuum equipment intended for collecting asbestos dust and waste, or for normal cleaning operations, must be so designed that the asbestos dust cannot escape from the equipment back into the workplace. With portable equipment, the collecting unit is located in the area where the cleaning is taking place; therefore, the filter must be of such efficiency as to prevent the escape of asbestos dust.

High efficiency particulate air (HEPA) filtered vacuum cleaners or vacuum systems with appropriate asbestos filters that are in accordance with the American Conference of Governmental Industrial Hygienists (ACGIH) Ventilation Manual or the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI 29.2-1971 are required by regulations.

There are two forms of vacuum cleaning units that can be used in the friable asbestos-containing facilities. One is a portable industrial vacuum cleaner that uses filter bags. The filtered air is returned to the working environment. The other system is a central vacuum cleaning setup that consists of a central suction and filtration unit from which ducts run to those parts of the facility in which vacuum cleaning is necessary. The first type of vacuum cleaning is adequate where an extensive facility hygiene operation is used at irregular and infrequent intervals.

In facility hygiene operations, it is very likely that dust will re-enter the air while changing HEPA filters in vacuum cleaning devices. Recommended procedures for handling these types of asbestos-contaminated material include the following:

1. Appropriate respirators and protective clothing must be used during all exposures to the fine dust found in vacuum equipment.
2. HEPA filters for the vacuum system should be disposable.
3. Water will cause damage to an HEPA filter. If a filter is going to be exposed to moisture, a prefilter dryer is required.
4. Asbestos-contaminated filters should be sealed in airtight 6-mil plastic bags.
5. Warning labels must be affixed to plastic bags containing asbestos waste, and they shall state the following warning:

   CAUTION
   DO NOT OPEN
   CONTAINS ASBESTOS FIBERS
   AVOID CREATING DUST
   BREATHING ASBESTOS DUST MAY CAUSE
   SERIOUS BODILY HARM

6. Asbestos waste must be dumped in state-approved sanitary landfill sites.

In the event the internal parts of the vacuum system become contaminated (other than filters), the unit should be removed from the workplace, preferably into the open air. The operator, equipped with approved

respiratory protection and protective clothing, should remove the collected material and place it into an impermeable plastic bag. Any material spilled into the body of the equipment should be carefully collected, preferably by using another vacuum cleaner. However, if this is not possible, the material should be removed by hand using a damp cloth. The contaminated cloth should be disposed of along with the asbestos waste material.

Amended Water

Wet cleaning methods considerably reduce the possibility of dust reentrainment. Under most circumstances, the effectiveness of wetting can be greatly enhanced by a wetting agent (Ref 1), thus reducing the amount of water required in the cleaning operation. When a wetting agent is added, it alters the surface tension of water, and, as a result, dust can penetrate into a droplet rather than just adhering to its surface, and fine particles are more easily cemented into large agglomerates (Ref 3). Thus, dust capture capability can often be increased many times. Portable pump equipment has been employed to clean large surface areas; however, the treated water could possibly bypass certain types of seals within this type of equipment.

Manufacturers and distributors of commercially available wetting agents* are listed as follows:

Aquatrols Corp. of America
1400 Suckle Highway
Pennsauken, NJ 08110

Leffingwell Chemical Co.
Box 188
Brea, CA 92921

Occidental Chemical Co.
Institutional Division
Box 198
Lathrop, CA 95330

Rohm and Haas Co.
Ag. Chemical Dept.
Independence Mall
W. Philadelphia, PA 19105

Target Chemical Co.
1280 N. 10th St.
San Jose, CA 95112

Thompson-Hayward Chemical Co.
Box 2383
Kansas City, KS 66110

Vineland Chemical Co.
Box 745
Vineland, NJ 08360

Amended water may cause flash rusting on ferrous surfaces. In these cases, repainting is in order. The wet cleaning procedure requires, of course, some attention to electrical safety and other operational problems associated with water in the presence of machinery and equipment.

Care must be taken for properly disposing of the wastewater so that a hazard is not created through the drying of surfaces where asbestos fibers accumulated during the wash down. The invisible fibers carried by water droplets can become reentrained in the work space once the water has evaporated. Asbestos fibers would tend to concentrate in bilges, pipe trenches, and sumps unless these areas were thoroughly flushed of residue material.

*This information should not be construed as a product endorsement by the Navy.

Currently there is not an Environmental Protection Agency criterion on asbestos fibers released into receiving bodies, fresh water or saltwater.

Some of the problems concerning fiber reentrainment from dry surfaces could be reduced if the fibers being washed down bilges and trenches were collected in sumps or bilge collection points. The wastewater from these collection points should be disposed of in a trench within state-approved sanitary landfills. The trench should be covered with an asbestos-free material before the water evaporates.

Chemical-Impregnated Equipment

Chemically treated cleaning equipment can be used for routine cleaning but should not be considered for initial or annual facility hygiene operations. The processing of this type of cleaning equipment requires special handling, and the management at the processing establishment must be informed of the potential contamination of the equipment by asbestos fibers.

RECOMMENDATIONS

Further investigation into asbestos-containing products is required to clarify the extent of fiber release, conditions under which it occurs, and procedures for controlling its release.

With the vast diversity of existing asbestos-containing thermal insulation products and the difficulties of assessment in the field, a device for rapid detection and assessment should be developed as stricter regulations are implemented by OSHA. A standardized coding system for labeling asbestos-containing products or asbestos-free products should be considered for shore activities as well as a flagging system for Public Works Department maintenance files.

REFERENCES

1. Civil Engineering Laboratory. Management procedure for assessment of friable asbestos insulating material. Port Hueneme, Calif. (to be published)

2. The Asbestos Research Council. The cleaning of premises and plant in accordance with the Asbestos Regulations, Control and Safety Guide No. 9. London, Apr 1978.

3. G. Rajhaus and G. Bragg. Engineering aspects of asbestos dust control. Ann Arbor, Mich., Ann Arbor Sci. Pub., Inc., 1978.

DISTRIBUTION LIST

AAP NAVORDSTA IND HD DET PW ENGRNG DIV, McAlester, OK
AFB (AFIT LD), Wright-Patterson OH; ABG DEE (F. Nethers), Goodfellow AFB TX; AF Tech Office (Mgt & Ops), Tyndall, FL; AFCEC XR,Tyndall FL; AUL LSE 63-465, Maxwell AL; CESCH, Wright-Patterson; HQ Tactical Air Cmd (R. E. Fisher), Langley AFB VA; MAC DET (Col. P. Thompson) Scott, IL; SAMSO MNND, Norton AFB CA; Samso, Vandenburg, AFB, CA; Stinfo Library, Offutt NE
ARMY BMDSC-RE (H. McClellan) Huntsville AL; DAEN-CWE-M (LT C D Binning), Washington DC; DAEN-MPE-D Washington DC; DAEN-MPU, Washington DC; ERADCOM Tech Supp Dir. (DELSD-L) Ft. Monmouth, NJ; Engr District (Memphis) Library, Memphis TN; Natick Cen (Kwoh Hu) Natick MA; Tech. Ref. Div., Fort Huachuca, AZ
ARMY - CERL Library, Champaign IL
ARMY AMMUNITION PLANT Sarhw - FEM Hawthorne, NY
ARMY CORPS OF ENGINEERS MRD-Eng. Div., Omaha NE; Seattle Dist. Library, Seattle WA
ARMY CRREL G. Phetteplace Hanover, NH
ARMY DARCOM AMCPM-CS (J. Carr), Alexandria VA
ARMY ENG DIV HNDED-CS, Huntsville AL; HNDED-SR, Huntsville, AL
ARMY ENGR DIST. Library, Portland OR
ARMY ENVIRON. HYGIENE AGCY Water Qual Div (Doner), Aberdeen Prov Ground, MD
ARMY MATERIALS & MECHANICS RESEARCH CENTER Dr. Lenoe, Watertown MA
ARMY MISSILE R&D CMD Redstone Arsenal AL Sci. Info. Cen (Documents)
ASO PWD (ENS J.A. Jenkins), Philadelphia, PA
ASST SECRETARY OF THE NAVY Spec. Assist Energy (Leonard), Washington, DC
BUREAU OF RECLAMATION Code 1512 (C. Selander) Denver CO
CINCLANT Civil Engr. Supp. Plans. Ofr Norfolk, VA
CNAVRES Code 13 (Dir. Facilities) New Orleans, LA
CNM Code MAT-08T3, Washington, DC
CNO Code NOP-964, Washington DC; Code OP 987 Washington DC; Code OP-413 Wash, DC; Code OPNAV 09B24 (H); OP987J (J. Boosman), Pentagon
COMFLEACT, OKINAWA PWO, Kadena, Okinawa
COMNAVMARIANAS Code N4, Guam
COMOCEANSYSPAC SCE, Pearl Harbor HI
COMSUBDEVGRUONE Operations Offr, San Diego, CA
DEFENSE CIVIL PREPAREDNESS AGENCY J.O. Buchanan, Washington DC
DOD Staff Spec. Chem. Tech, Washington DC
DOE F.F. Parry, Washington DC; INEL Tech. Lib. (Reports Section), Idaho Falls, ID; Liffick, Richmond, WA; P. Jordan Washington, DC
DTIC Defense Technical Info Ctr/Alexandria, VA
DTNSRDC Code 4111 (R. Gierich), Bethesda MD; Code 42, Bethesda MD
DTNSRDC Code 522 (Library), Annapolis MD
ENVIRONMENTAL PROTECTION AGENCY Reg. VIII, 8M-ASL, Denver CO
FLTCOMBATTRACENLANT PWO, Virginia Bch VA
GSA Fed. Sup. Serv. (FMBP), Washington DC; Office of Const. Mgmt (M. Whitley), Washington DC
KWAJALEIN MISRAN BMDSC-RKL-C
LIBRARY OF CONGRESS Washington, DC (Sciences & Tech Div)
MARINE CORPS BASE Camp Pendleton CA 92055; Code 43-260, Camp Lejeune NC; M & R Division, Camp Lejeune NC; PWO Camp Lejeune NC; PWO, Camp S. D. Butler, Kawasaki Japan
MARINE CORPS HQS Code LFF-2, Washington DC
MCAS Facil. Engr. Div. Cherry Point NC; CO, Kaneohe Bay HI; Code PWE, Kaneohe Bay HI; Code S4, Quantico VA; PWD, Dir. Maint. Control Div., Iwakuni Japan; PWO Kaneohe Bay HI; PWO, Yuma AZ; SCE, Futema Japan
MCDEC NSAP REP, Quantico VA
MCLSBPAC B520, Barstow CA; PWO, Barstow CA
MCRD PWO, San Diego Ca
NAF PWD - Engr Div, Atsugi, Japan; PWO Sigonella Sicily; PWO, Atsugi Japan
NALF OINC, San Diego, CA
NARF Code 100, Cherry Point, NC; Code 612, Jax, FL; Code 640, Pensacola FL

NAS CO, Guantanamo Bay Cuba; Code 114, Alameda CA; Code 183 (Fac. Plan BR MGR); Code 187, Jacksonville FL; Code 18700, Brunswick ME; Code 18U (ENS P.J. Hickey), Corpus Christi TX; Code 6234 (G. Trask), Point Mugu CA; Code 70, Atlanta, Marietta GA; Code 8E, Patuxent Riv., MD; Dir. Util. Div., Bermuda; ENS Buchholz, Pensacola, FL; Lakehurst, NJ; Lead. Chief. Petty Offr. PW/Self Help Div, Beeville TX; PW (J. Maguire), Corpus Christi TX; PWD Maint. Cont. Dir., Fallon NV; PWD Maint. Div., New Orleans, Belle Chasse LA; PWD, Maintenance Control Dir., Bermuda; PWD, Willow Grove PA; PWO Belle Chasse, LA; PWO Chase Field Beeville, TX; PWO Key West FL; PWO Whiting Fld, Milton FL; PWO, Dallas TX; PWO, Glenview IL; PWO, Kingsville TX; PWO, Millington TN; PWO, Miramar, San Diego CA; PWO., Moffett Field CA; ROICC Key West FL; SCE Lant Fleet Norfolk, VA; SCE Norfolk, VA; SCE, Barbers Point HI; Security Offr, Alameda CA

NATL RESEARCH COUNCIL Naval Studies Board, Washington DC

NATNAVMEDCEN PWO Bethesda, MD

NAVACT PWO, London UK

NAVACTDET PWO, Holy Lock UK

NAVAEROSPREGMEDCEN SCE, Pensacola FL

NAVCOASTSYSTCTR CO, Panama City FL; Code 423 (D. Good), Panama City FL; Code 713 (J. Quirk) Panama City, FL; Library Panama City, FL

NAVCOMMAREAMSTRSTA PWO, Norfolk VA; PWO, Wahiawa HI; SCE Unit 1 Naples Italy

NAVCOMMSTA CO (61E) Puerto Rico; Code 401 Nea Makri, Greece; PWO, Exmouth, Australia; PWO, Fort Amador Canal Zone

NAVEDTRAPRODEVCEN Tech. Library

NAVEDUTRACEN Engr Dept (Code 42) Newport, RI

NAVENVIRHLTHCEN CO, Norfolk, VA

NAVFAC PWO, Brawdy Wales UK; PWO, Cape Hatteras, Buxton NC; PWO, Centerville Bch, Ferndale CA; PWO, Guam

NAVFAC PWO, Lewes DE

NAVFACENGCOM Code 043 Alexandria, VA; Code 044 Alexandria, VA; Code 0451 Alexandria, VA; Code 0454B Alexandria, Va; Code 046; Code 0461D (V M Spaulding) Alexandria, VA; Code 04B3 Alexandria, VA; Code 081B Alexandria, VA; Code 100 Alexandria, VA; Code 1113 (M. Carr) Alexandria, VA; Code 1113 (T. Stevens) Alexandria, VA; Morrison Yap, Caroline Is.

NAVFACENGCOM - CHES DIV. Code 101 Wash, DC; Code 102, (Wildman), Wash, DC; Code 403 (H. DeVoe) Wash, DC; Code FPO-1 Wash, DC

NAVFACENGCOM - LANT DIV. CDR E. Peltier; Code 10A, Norfolk VA; Code 111, Norfolk, VA; Eur. BR Deputy Dir, Naples Italy; European Branch, New York; RDT&ELO 102, Norfolk VA

NAVSTA AROICC, Brooklyn NY

NAVFACENGCOM - NORTH DIV. CO; Code 09P (LCDR A.J. Stewart); Code 1028, RDT&ELO, Philadelphia PA; Code 111 (Castranovo) Philadelphia, PA; Design Div. (R. Masino), Philadelphia PA; ROICC, Contracts, Crane IN

NAVFACENGCOM - PAC DIV. (Kyi) Code 101, Pearl Harbor, HI; Code 402, RDT&E, Pearl Harbor HI, Commander, Pearl Harbor, HI

NAVFACENGCOM - SOUTH DIV. Code 90, RDT&ELO, Charleston SC

NAVFACENGCOM - WEST DIV. 102; 112; AROICC, Contracts, Twentynine Palms CA; Code 04B San Bruno, CA; O9P/20 San Bruno, CA; RDT&ELO Code 2011 San Bruno, CA

NAVFACENGCOM CONTRACT AROICC, Quantico, VA; Code 05, TRIDENT, Bremerton WA; Code 09E, TRIDENT, Bremerton WA; Dir, Eng. Div., Exmouth, Australia; Eng Div dir, Southwest Pac, Manila, PI; Engr. Div. (F. Hein), Madrid, Spain; OICC (Knowlton), Kaneohe, HI; OICC, Southwest Pac, Manila, PI; OICC/ROICC, Balboa Canal Zone; ROICC AF Guam; ROICC, Keflavik, Iceland; ROICC, Pacific, San Bruno CA

NAVMAG SCE, Guam

NAVNUPWRU MUSE DET Code NPU-30 Port Hueneme, CA

NAVOCEANSYSCEN Code 41, San Diego, CA; Code 523 (Hurley), San Diego, CA; Code 6700, San Diego, CA; Code 811 San Diego, CA; Research Lib., San Diego CA; Tech. Library, Code 447

NAVORDSTA PWO, Louisville KY

NAVPETOFF Code 30, Alexandria VA

NAVPETRES Director, Washington DC

NAVPHIBASE CO, ACB 2 Norfolk, VA; Code S3T, Norfolk VA

NAVRADRECFAC PWO, Kami Seya Japan

NAVREGMEDCEN Code 3041, Memphis, Millington TN; PWO Newport RI; SCE San Diego, CA; SCE, Camp Pendleton CA; SCE, Guam; SCE, Oakland CA
NAVSCOLCECOFF C35 Port Hueneme, CA; CO, Code C44A Port Hueneme, CA
NAVSEASYSCOM Code 0325, Program Mgr, Washington, DC; Code OOC (LT R. MacDougal), Washington DC; Code SEA OOC Washington, DC
NAVSEC Code 6034 (Library), Washington DC
NAVSECGRUACT PWO, Adak AK; PWO, Edzell Scotland; PWO, Puerto Rico; PWO, Torri Sta, Okinawa
NAVSHIPREPFAC Library, Guam
NAVSHIPYD Code 202.4, Long Beach CA; Code 202.5 (Library) Puget Sound, Bremerton WA; Code 380, (Woodroff) Norfolk, Portsmouth, VA; Code 400, Puget Sound; Code 400.03 Long Beach, CA; Code 404 (LT J. Riccio), Norfolk, Portsmouth VA; Code 410, Mare Is., Vallejo CA; Code 440 Portsmouth NH; Code 440, Norfolk; Code 440, Puget Sound, Bremerton WA; Code 450, Charleston SC; Code 453 (Util. Supr), Vallejo CA; L.D. Vivian; Library, Portsmouth NH; PWD (Code 400), Philadelphia PA; PWO, Mare Is.; PWO, Puget Sound; SCE, Pearl Harbor HI; Tech Library, Vallejo, CA
NAVSTA CO Naval Station, Mayport FL; CO Roosevelt Roads P.R. Puerto Rico; Dir Mech Engr, Gtmo; Engr. Dir., Rota Spain; Long Beach, CA; Maint. Cont. Div., Guantanamo Bay Cuba; Maint. Div. Dir/Code 531, Rodman Canal Zone; PWD (LTJG.P.M. Motolenich), Puerto Rico; PWO Midway Island; PWO, Guantanamo Bay Cuba; PWO, Keflavik Iceland; PWO, Mayport FL; ROICC Rota Spain; ROICC, Rota Spain; SCE, Guam; SCE, San Diego CA; SCE, Subic Bay, R.P.; Utilities Engr Off. (A.S. Ritchie), Rota Spain
NAVSUBASE ENS S. Dove, Groton, CT; SCE, Pearl Harbor HI
NAVSUPPACT CO, Seattle WA
NAVSTA Code 4, 12 Marine Corps Dist, Treasure Is., San Francisco CA
NAVSUPPACT Code 413, Seattle WA; LTJG McGarrah, SEC, Vallejo, CA; Plan/Engr Div., Naples Italy
NAVSURFWPNCEN PWO, White Oak, Silver Spring, MD
NAVTECHTRACEN SCE, Pensacola FL
NAVUSEAWARENGSTA Keyport, WA
NAVWPNCEN Code 2636 (W. Bonner), China Lake CA; PWO (Code 26), China Lake CA; ROICC (Code 702), China Lake CA
NAVWPNEVALFAC Technical Library, Albuquerque NM
NAVWPNSTA (Clebak) Colts Neck, NJ; Code 092, Colts Neck NJ; Code 092A (C. Fredericks) Seal Beach CA; Maint. Control Dir., Yorktown VA
NAVWPNSTA PW Office (Code 09C1) Yorktown, VA
NAVWPNSTA PWO, Seal Beach CA
NAVWPNSUPPCEN Code 09 Crane IN
NCBU 405 OIC, San Diego, CA
NCBC Code 10 Davisville, RI; Code 155, Port Hueneme CA; Code 156, Port Hueneme, CA; Code 25111 Port Hueneme, CA; Code 400, Gulfport MS; NESO Code 251 P.R. Winter Port Hueneme, CA; PW Engrg, Gulfport MS; PWO (Code 80) Port Hueneme, CA; PWO, Davisville RI
NCBU 411 OIC, Norfolk VA
NCR 20, Commander
NCSO BAHRAIN Security Offr, Bahrain
NMCB 5, Operations Dept.; Forty, CO; THREE, Operations Off.
NOAA Library Rockville, MD
NRL Code 8400 Washington, DC
NSC Code 54.1 (Wynne), Norfolk VA
NSD SCE, Subic Bay, R.P.
NTC Commander Orlando, FL; OICC, CBU-401, Great Lakes IL
NUSC Code 131 New London, CT; Code EA123 (R.S. Munn), New London CT; Code S332, B-80 (J. Wilcox); Code SB 331 (Brown), Newport RI
OCEANSYSLANT LT A.R. Giancola, Norfolk VA
OFFICE SECRETARY OF DEFENSE OASD (MRA&L) Pentagon (T. Casberg), Washington, DC
ONR Code 221, Arlington VA; Code 700F Arlington VA; Dr. A. Laufer, Pasadena CA
PHIBCB 1 P&E, Coronado, CA
PMTC Code 3331 (S. Opatowsky) Point Mugu, CA; Pat. Counsel, Point Mugu CA
PWC (Lt E.S. Agonoy) Pensacola, FL; ACE Office (LTJG St. Germain) Norfolk VA; CO Norfolk, VA; CO, (Code 10), Oakland, CA; CO, Great Lakes IL; Code 10, Great Lakes, IL; Code 110, Oakland, CA; Code 120, Oakland CA; Code 120C, (Library) San Diego, CA; Code 128, Guam; Code 154, Great Lakes, IL;

Code 200, Great Lakes IL; Code 200, Guam; Code 220 Oakland, CA; Code 220.1 Norfolk VA; Code 300 San Diego, CA; Code 400, Great Lakes, IL; Code 400, Oakland, CA; Code 400, Pearl Harbor HI; Code 400, San Diego, CA; Code 420, Great Lakes, IL; Code 420, Oakland, CA; Code 42B (R. Pascua) Pearl Harbor HI; Code 505A (H. Wheeler); Code 600, Great Lakes, IL; Code 601, Oakland, CA; Code [illegible] San Diego Ca; Code 700, Great Lakes, IL; LTJG J.L. McClaine, Yokosuka, Japan; Utilities Officer, Guam; XO (Code 20) Oakland, CA

SPCC PWO (Code 120) Mechanicsburg PA

TVA Smelser, Knoxville, Tenn.

NAF PWO (Code 30) El Centro, CA

U.S. MERCHANT MARINE ACADEMY Kings Point, NY (Reprint Custodian)

US DEPT OF COMMERCE NOAA, Pacific Marine Center, Seattle WA

US GEOLOGICAL SURVEY Off. Marine Geology, Piteleki, Reston VA

USAF Jack S. Spencer, Washington, DC

USAF REGIONAL HOSPITAL Fairchild AFB, WA

USCG (G-ECV) Washington Dc; (Smith), Washington, DC

USCG R&D CENTER D. Motherway, Groton CT; Tech. Dir. Groton, CT

USDA Forest Products Lab, Madison WI; Forest Service, Bowers, Atlanta, GA; Forest Service, San Dimas, CA

USNA Ch. Mech. Engr. Dept Annapolis MD; Energy-Environ Study Grp, Annapolis, MD; Engr. Div. (C. Wu) Annaplolis MD; Environ. Prot. R&D Prog. (J. Williams), Annapolis MD; Ocean Sys. Eng Dept (Dr. Monney) Annapolis, MD; PWD Engr. Div. (C. Bradford) Annapolis MD; PWO Annapolis MD

ARIZONA State Energy Programs Off., Phoenix AZ

AVALON MUNICIPAL HOSPITAL Avalon, CA

BONNEVILLE POWER ADMIN Portland OR (Energy Consrv. Off., D. Davey)

BROOKHAVEN NATL LAB M. Steinberg, Upton NY

CALIFORNIA STATE UNIVERSITY LONG BEACH, CA (CHELAPATI)

COLUMBIA-PRESBYTERIAN MED. CENTER New York, NY

CORNELL UNIVERSITY Ithaca NY (Serials Dept, Engr Lib.)

DAMES & MOORE LIBRARY LOS ANGELES, CA

FLORIDA ATLANTIC UNIVERSITY Boca Raton, FL (McAllister)

FLORIDA TECHNOLOGICAL UNIVERSITY ORLANDO, FL (HARTMAN)

FOREST INST. FOR OCEAN & MOUNTAIN Carson City NV (Studies - Library)

FUEL & ENERGY OFFICE CHARLESTON, WV

GEORGIA INSTITUTE OF TECHNOLOGY (LT R. Johnson) Atlanta, GA

HAWAII STATE DEPT OF PLAN. & ECON DEV. Honolulu HI (Tech Info Ctr)

INDIANA ENERGY OFFICE Energy Group, Indianapolis, IN

WOODS HOLE OCEANOGRAPHIC INST. Woods Hole MA (Winget)

KEENE STATE COLLEGE Keene NH (Cunningham)

LEHIGH UNIVERSITY BETHLEHEM, PA (MARINE GEOTECHNICAL LAB., RICHARDS); Bethlehem PA (Linderman Lib. No.30, Flecksteiner)

LOUISIANA DIV NATURAL RESOURCES & ENERGY Dept. of Conservation, Baton Rouge LA

MAINE OFFICE OF ENERGY RESOURCES Augusta, ME

MICHIGAN TECHNOLOGICAL UNIVERSITY Houghton, MI (Haas)

MISSOURI ENERGY AGENCY Jefferson City MO

MIT Cambridge MA (Rm 10-500, Tech. Reports, Engr. Lib.); Cambridge, MA (Harleman)

MONTANA ENERGY OFFICE Anderson, Helena, MT

NATL ACADEMY OF ENG. ALEXANDRIA, VA (SEARLE, JR.)

NEW HAMPSHIRE Concord, NH. (Governor's Council On Energy)

NEW MEXICO SOLAR ENERGY INST. Dr. Zwibel Las Cruces NM

NY CITY COMMUNITY COLLEGE BROOKLYN, NY (LIBRARY)

NYS ENERGY OFFICE Library, Albany NY

POLLUTION ABATEMENT ASSOC. Graham

PURDUE UNIVERSITY Lafayette, IN (Altschaeffl); Lafayette, IN (CE Engr. Lib)

CONNECTICUT Hartford CT (Dept of Plan. & Energy Policy)

SCRIPPS INSTITUTE OF OCEANOGRAPHY LA JOLLA, CA (ADAMS)

SEATTLE U Prof Schwaegler Seattle WA

STANFORD UNIVERSITY Engr Lib, Stanford CA

STATE UNIV. OF NEW YORK Fort Schuyler, NY (Longobardi)

TEXAS A&M UNIVERSITY W.B. Ledbetter College Station, TX

UNIVERSITY OF CALIFORNIA DAVIS, CA (CE DEPT, TAYLOR); Energy Engineer, Davis CA
LIVERMORE, CA (LAWRENCE LIVERMORE LAB, TOKARZ); La Jolla CA (Acq. Dept, Lib. C-075A)
UNIVERSITY OF DELAWARE Newark, DE (Dept of Civil Engineering, Chesson)
UNIVERSITY OF HAWAII HONOLULU, HI (SCIENCE AND TECH. DIV.)
UNIVERSITY OF ILLINOIS URBANA, IL (LIBRARY); URBANA, IL (NEWMARK)
UNIVERSITY OF MASSACHUSETTS (Heronemus), Amherst MA CE Dept
UNIVERSITY OF NEBRASKA-LINCOLN Lincoln, NE (Ross Ice Shelf Proj.)
UNIVERSITY OF TEXAS Inst. Marine Sci (Library), Port Arkansas TX
UNIVERSITY OF TEXAS AT AUSTIN AUSTIN, TX (THOMPSON)
UNIVERSITY OF WASHINGTON (FH-10, D. Carlson) Seattle, WA; Dept of Civil Engr (Dr. Mattock), Seattle WA; Seattle WA (E. Linger); Seattle, WA Transportation, Construction & Geom. Div
UNIVERSITY OF WISCONSIN Milwaukee WI (Ctr of Great Lakes Studies)
VIRGINIA INST. OF MARINE SCI. Gloucester Point VA (Library)
ARVID GRANT OLYMPIA, WA
ATLANTIC RICHFIELD CO. DALLAS, TX (SMITH)
BAGGS ASSOC. Beaufort, SC
BECHTEL CORP. SAN FRANCISCO, CA (PHELPS)
BRITISH EMBASSY Sci. & Tech. Dept. (J. McAuley), Washington DC
BROWN & CALDWELL E M Saunders Walnut Creek, CA
BROWN & ROOT Houston TX (D. Ward)
CANADA Nova Scotia Rsch Found. Corp. Dartmouth, Nova Scotia; Surveyor, Nenninger & Chenevert Inc., Montreal; Trans-Mnt Oil Pipe Lone Corp. Vancouver, BC Canada
CHEMED CORP Lake Zurich IL (Dearborn Chem. Div. Lib.)
COLUMBIA GULF TRANSMISSION CO. HOUSTON, TX (ENG. LIB.)
DESIGN SERVICES Beck, Ventura, CA
DILLINGHAM PRECAST F. McHale, Honolulu HI
DIXIE DIVING CENTER Decatur, GA
DURLACH, O'NEAL, JENKINS & ASSOC. Columbia SC
FORD, BACON & DAVIS, INC. New York (Library)
GRUMMAN AEROSPACE CORP. Bethpage NY (Tech. Info. Ctr)
HONEYWELL, INC. Minneapolis MN (Residential Engr Lib.)
MATRECON Oakland, CA (Haxo)
MCDONNEL AIRCRAFT CO. Dept 501 (R.H. Fayman), St Louis MO
MEDERMOTT & CO. Diving Division, Harvey, LA
MIDLAND-ROSS CORP. TOLEDO, OH (RINKER)
NEWPORT NEWS SHIPBLDG & DRYDOCK CO. Newport News VA (Tech. Lib.)
PACIFIC MARINE TECHNOLOGY Duvall, WA (Wagner)
PORTLAND CEMENT ASSOC. SKOKIE, IL (CORLEY; SKOKIE, IL (KLIEGER); Skokie IL (Rsch & Dev Lab, Lib.)
RAYMOND INTERNATIONAL INC. E Colle Soil Tech Dept, Pennsauken, NJ
SANDIA LABORATORIES Albuquerque, NM (Vortman); Library Div., Livermore CA
SCHUPACK ASSOC SO. NORWALK, CT (SCHUPACK)
SEAFOOD LABORATORY MOREHEAD CITY, NC (LIBRARY)
SEATECH CORP. MIAMI, FL (PERONI)
SHELL DEVELOPMENT CO. Houston TX (C. Sellars Jr.)
SWEDEN Cement & Concrete Research Inst., Stockholm; VBB (Library), Stockholm
TEXTRON INC BUFFALO, NY (RESEARCH CENTER LIB.)
TRW SYSTEMS REDONDO BEACH, CA (DAI)
UNITED KINGDOM Cement & Concrete Assoc Wexham Springs, Slough Bucks; Library, Bristol; R. Browne Southall, Middlesex; Taylor, Woodrow Constr (014P), Southall, Middlesex; Taylor, Woodrow Constr (Smith), Southall, Middlesex; Univ. of Bristol (R. Morgan), Bristol
UNITED TECHNOLOGIES Windsor Locks CT (Hamilton Std Div., Library)
WARD, WOLSTENHOLD ARCHITECTS Sacramento, CA
WESTINGHOUSE ELECTRIC CORP. Annapolis MD (Oceanic Div Lib, Bryan); Library, Pittsburgh PA
WM CLAPP LABS - BATTELLE DUXBURY, MA (LIBRARY)
BRAHTZ La Jolla, CA
ERVIN, DOUG Belmont, CA

KETRON, BOB Ft Worth, TX
KRUZIC, J P Silver Spring, MD
CAPT MURPHY Sunnyvale, CA
T W MERMEL Washington DC

DAT
ILM